

Audit



Report

OFFICE OF THE INSPECTOR GENERAL

**COST-EFFECTIVENESS ANALYSES FOR THE AIR FORCE
C-17 PROGRAM**

Report Number 92-089

May 12, 1992

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The following acronyms are used in this report.

ASD(PA&E).....	Assistant Secretary of Defense (Program Analysis and Evaluation)
C-X.....	New Airlifter
COEA.....	Cost and Operational Effectiveness Analysis
DAB.....	Defense Acquisition Board
GAO.....	General Accounting Office
GFE.....	Government-Furnished Equipment
LCN.....	Load Classification Number
MAC.....	Military Airlift Command
MAR.....	Major Aircraft Review
MRS.....	Mobility Requirements Study
MTM/D.....	Million Ton-Miles Per Day
PAA.....	Primary Authorized Aircraft
PAUC.....	Program Acquisition Unit Cost
PDM.....	Programmed Depot Maintenance
SAB.....	Scientific Advisory Board
SLEP.....	Service-Life Extension Program
T-1.....	Flight Test Aircraft
USD(A).....	Under Secretary of Defense for Acquisition



INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202-2884



May 12, 1992

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL
MANAGEMENT AND COMPTROLLER)

SUBJECT: Audit Report on Cost-Effectiveness Analyses for the
Air Force C-17 Program (Report No. 92-089)

We are providing this final report for your information and use. Comments on a draft of this report were considered in preparing the final report. DoD Directive 7650.3 requires that all audit recommendations be resolved promptly. Therefore, all addressees must provide final comments on the unresolved recommendations by July 10, 1992. See the "Status of Recommendations" section at the end of the finding for recommendations you must comment on and the specific requirements for your comments. Recommendations are subject to resolution in accordance with DoD Directive 7650.3 in the event of nonconcurrence or failure to comment. We also ask that your comments indicate concurrence or nonconcurrence with the material internal control weakness highlighted in Part I.

We appreciate the courtesies extended to the audit staff. If you have any questions on this audit, please contact Mr. Russell A. Rau, Program Director, at (703) 693-0186 (DSN 223-0186) or Mr. Jack D. Snider, Project Manager, at (703) 614-3999 (DSN 224-3999). The planned distribution of this report is listed in Appendix H.

Robert J. Lieberman
Assistant Inspector General
for Auditing

Enclosure

cc:
Secretary of the Air Force
Comptroller of the Department of Defense

Office of the Inspector General

AUDIT REPORT NO. 92-089
(Project No. 1AE-5020)

May 12, 1992

COST-EFFECTIVENESS ANALYSES FOR THE AIR FORCE C-17 PROGRAM

EXECUTIVE SUMMARY

Introduction. The Air Force's C-17 aircraft was designed to modernize the airlift fleet and improve the overall capability of the United States to rapidly project, reinforce, and sustain combat forces worldwide. The aircraft will augment the C-5 and C-141 aircraft in intertheater deployment and the C-130 in intratheater operations and subsequently replace the C-141 fleet and reduce the size of the C-130 fleet. The aircraft will be capable of carrying outsize cargo over intertheater ranges into austere airfields, thereby introducing a direct deployment capability that will significantly improve airlift responsiveness. The C-17 will provide significant intertheater airlift capability toward meeting the recommendations of the congressionally mandated Mobility Requirements Study (MRS), which was updated in January 1992.

Objective. The Senate Armed Services Committee (Committee) requested that the DoD Inspector General evaluate the continued cost-effectiveness of the Air Force C-17 Program (C-17 Program). The Committee requested that we review DoD and Air Force life-cycle cost and performance analyses, the validity of the models used to make effectiveness calculations, and the reasonableness of the scenarios used in these models.

Audit Results. Cost-effectiveness analyses performed of alternatives to the C-17 aircraft adequately supported continuation of the 120-aircraft C-17 Program. However, OSD and Air Force analyses were limited in that performance of a C-141 service-life extension program (SLEP), as a complement to the 120-aircraft C-17 Program, was not adequately considered as a means of reducing long-term airlift costs associated with fulfilling mission needs identified in the MRS directed by Congress. Those needs cannot be met by the 120-aircraft C-17 Program alone, nor is an expanded C-17 Program necessarily the best way to meet the requirement. Audit results specifically addressing the Committee tasking are addressed in Appendix A of this report.

Internal Controls. The audit identified a material internal control weakness in that controls were not implemented to ensure that OSD and Air Force officials make future C-17 production decisions based on up-to-date cost and operational effectiveness analyses (COEAs). The internal control weakness is further discussed in Part I of the report.

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Potential Benefits of Audit. Potential monetary benefits are not readily quantifiable (Appendix F). Savings would result from a complementary fleet of C-17 and C-141 aircraft if determined by DoD management to meet the airlift mission.

Summary of Recommendations. We recommended that a COEA be performed and a special Defense Acquisition Board program review of the C-17 Program be conducted before the Lot V production decision. We also recommended that a SLEP for the C-141 aircraft fleet be assessed as part of the COEA of fulfilling the requirements in the MRS.

Management Comments. The Under Secretary of Defense for Acquisition and the Assistant Secretary of the Air Force (Acquisition) nonconcurred with our finding and recommendations. The complete texts of their comments are in Part IV of the report. We request that these officials reconsider their position and provide additional comments to the final report by July 10, 1992.

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The Acquisition Management Directorate, Office of the Assistant Inspector General for Auditing, DoD, prepared this report. Copies of this report can be obtained from the Information Officer, Audit Planning and Technical Support Directorate, at (703) 614-6303 (DSN 224-6303).

PART I - INTRODUCTION

Background

In 1981, the Air Force initiated development of the C-17 aircraft to provide additional capability to airlift the full range of DoD cargo and to provide military capabilities not available in any one cargo aircraft. The C-17 is designed to meet shortfalls in long-range airlift capability by providing an all-weather, air-refuelable aircraft capable of operating from small, austere airfields and delivering troops and all types of cargo for intertheater and intratheater operations. Initially, the Air Force planned to buy 210 C-17 aircraft for an estimated \$42 billion. However, in April 1990, during the Major Aircraft Review (MAR), the Secretary of Defense reduced the quantity of C-17 aircraft to be procured to 120 because of anticipated reductions in DoD budgets and a reduction in the multitheater global war threat. As of January 25, 1992, the estimated program acquisition cost of the 120 aircraft was \$35.4 billion.

In December 1985, the Air Force awarded contract F33657-81-C-2108 to Douglas Aircraft Company (Douglas) for the full-scale engineering development and testing of one flight test aircraft (T-1) and two ground test articles. On January 13, 1988, and July 28, 1989, the Air Force exercised options for two (Lot I) and four (Lot II) production aircraft, respectively. As of July 1991, the ceiling price for development and first two production lots was \$6.6 billion. On July 25, 1991, the Under Secretary of Defense for Acquisition [USD(A)] approved the award of the Lot III production contract to acquire four additional aircraft. The target and ceiling prices were \$1.03 billion and \$1.22 billion, respectively. Congress appropriated FY 1991 procurement funds of \$460 million for two aircraft; however, no FY 1991 production contract was awarded and the funds were applied to other uses, including the FY 1992 buy, because the funds appropriated were insufficient to procure a lot buy of two aircraft with supporting assets. The Air Force is scheduled to award Lot IV for four aircraft in August 1992. About \$1.53 billion, \$381 million per aircraft, was appropriated in FY 1992 for this purpose. The Air Force is scheduled to award the Lot V contract for up to eight C-17 aircraft in March 1993. First flight of T-1, which was originally scheduled for February 1990, occurred on September 15, 1991.

In the "National Defense Authorization Act for Fiscal Years 1992 and 1993 Report," July 19, 1991, the Senate Armed Services Committee (Committee) directed the Chairman of the Joint Chiefs of Staff to certify that the C-17 aircraft continues to be the most cost-effective means to meet current and projected airlift requirements.

Objective

The overall audit objective was to evaluate the continued cost-effectiveness of the Air Force C-17 Program (C-17 Program). In the "National Defense Authorization Act for Fiscal Years 1992 and 1993 Report," July 19, 1991, the Committee directed the audit and requested:

. . . the Defense Department Inspector General to review the Department of Defense's and the Air Force's life-cycle cost and performance analyses, and provide an independent assessment of whether these analyses are still valid. The committee believes that the IG should pay particular attention to changes in major specifications, such as weight, fuel consumption, cargo capacity, and maximum range. This assessment should also analyze the validity of the models used to make the effectiveness calculations and the reasonableness of the scenarios used in the models.

Appendix A specifically addresses the results of our audit in response to the Committee tasking.

Scope

We performed this program audit in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD, and accordingly included such tests of internal controls as were deemed necessary.

We performed the audit from August 1991 through May 1992, and reviewed data and information dated from 1981 through 1992. We reviewed cost-effectiveness analyses performed by OSD and the Air Force. We discussed cost and operational effectiveness issues with Government and contractor personnel. We also reviewed DoD and Air Force life-cycle cost and performance analyses, including the reasonableness of the scenarios used in these analyses. A list of the activities visited or contacted is in Appendix G.

The Quantitative Methods Division of the Audit Planning and Technical Support Directorate, Office of the Inspector General, supported the review of the validity of the models used to make effectiveness calculations that were included in the DoD and Air Force analyses.

Internal Controls

The audit identified a material internal control weakness as defined by Public Law 97-255, Office of Management and Budget Circular A-123, and DoD Directive 5010.38. The audit concluded that existing internal controls, if properly implemented, were adequate to prevent or detect the deficiencies identified in this report. Specifically, the controls established by DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 23, 1991, should ensure that cost and operational effectiveness analyses (COEAs) are performed at Milestone II, and updated, if necessary, prior to Milestone III. However, the Air Force had not accomplished a formal COEA of the C-17 Program and did not intend to accomplish the analysis until just prior to the award of the Lot VII production contract. This is essentially too late in the C-17 Program to prudently assess cost and operational effectiveness as now required by DoD Instruction 5000.2, because 34 aircraft will already be on contract of a planned 120-aircraft program. Implementation of Recommendations 1. and 3. will help correct this weakness.

Copies of the final report will be provided to the senior officials responsible for internal controls within OSD and the Department of the Air Force.

Prior Audits and Other Reviews

General Accounting Office (GAO) Report No. GAO/NSIAD-87-97 (OSD Case No. 7197), "Military Airlift: Air Force Analysis Supports Acquisition of C-17 Aircraft," March 20, 1987, concluded that the C-17 was preferred over the C-5. For additional details concerning this report, see Appendix B.

PART II - FINDING AND RECOMMENDATIONS

COST AND OPERATIONAL EFFECTIVENESS ANALYSIS

The Air Force had not conducted a formal COEA of the C-17 Program after major changes that affected the C-17 Program occurred. The OSD and the Air Force conducted adequate cost analyses supporting continuation of the C-17 Program compared to other viable alternatives, but did not assess the most cost-effective airlift fleet potentially comprised of new C-17 aircraft and C-141 aircraft that had undergone a service-life extension program (SLEP), in addition to the existing fleet of other airlift aircraft. A COEA of complementary airlift fleets was not performed because the Mobility Requirements Study (MRS) had not been completed, and the Air Force considered the C-17 aircraft to be the most cost-effective alternative under any scenario because of its unique capabilities, including direct delivery of outsize cargo. The Air Force can potentially reduce the cost of meeting long-term airlift mission requirements through a complementary mix of C-141 SLEP and C-17 aircraft. For example, there is a potential for significant savings if the MRS-projected airlift shortfall after FY 1999 could be satisfied through a SLEP of 152 C-141 aircraft versus procurement of an additional 34 C-17 aircraft.

DISCUSSION OF DETAILS

Background

DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 23, 1991, part 4, and DoD 5000.2-M, "Defense Acquisition Management Documentation and Reports," February 23, 1991, part 8, provide general procedures and guidelines for COEAs. The COEAs evaluate the costs and benefits, such as operational effectiveness or military utility, of alternative courses of action to meet recognized Defense needs. The COEAs are required to be prepared and considered at milestone decision reviews. They aid decisionmaking, facilitate communications, and document acquisition decisions by highlighting the advantages and disadvantages of the alternatives being considered and showing the sensitivity of each alternative to possible changes in key assumptions, such as threat, or variables, including selected performance capabilities. Further, COEAs provide early identification and discussion of reasonable alternatives among decisionmakers and staffs at all levels. Disagreements on key assumptions and variables must be explicitly identified and should not be immersed in the presentation of a compromise position. Additionally, COEAs must have thresholds that are the maximum cost or minimum acceptable performance that can be tolerated in a system.

The DoD Component responsible for the mission area in which a deficiency or opportunity is identified normally prepares the COEA. The DoD Component head determines the independent analysis activity to prepare the COEA. The Joint Staff should ensure that the full range of alternatives is considered, organizational and operational plans are developed, and joint-Service issues are addressed.

The Assistant Secretary of Defense (Program Analysis and Evaluation) [ASD(PA&E)] has primary responsibility for assessing the adequacy of COEAs submitted in support of Defense Acquisition Board (DAB) reviews. The ASD(PA&E) will provide, as necessary, guidance tailored to the program under review to be included in the DAB review procedures from the USD(A). In the DAB process, the COEA is required at milestone decision reviews starting with Milestone I. At Milestones III and IV, the analysis is an update of the previous analysis required at Milestone II. The elements of the updated analysis for a Milestone III review will be specified by the milestone decision authority as part of the premilestone planning process.

C-17 Cost and Operational Effectiveness Analysis

Major changes have occurred that affected the C-17 Program; however, the Air Force did not conduct a formal COEA to assess the most cost-effective way of meeting long-term airlift mission requirements. The Air Force had not previously conducted a formal COEA on the C-17 Program and did not intend to accomplish the analysis until prior to the Lot VII contract award based on the Milestone III Production and Deployment decision, when up to 34 aircraft will already be on contract. Numerous analyses conducted, while adequate for their intended purposes, do not satisfy the objectives of a formal COEA, including with regard to identifying the optimal means for satisfying Defense requirements. On July 19, 1991, the Committee tasked the Chairman of the Joint Chiefs of Staff to perform a cost-effectiveness analysis of the C-17 Program. The analysis is currently ongoing and provides the opportunity to address the potential benefits of a complementary mix of C-17 and C-141 SLEP aircraft to fulfill mission requirements. The major changes in the C-17 Program included a variance in the C-17 Program buy, a reduction in the maximum payload mission, a slippage in aircraft delivery, and an increase in unit cost.

Program buy. In April 1990, the Secretary of Defense conducted the MAR, which resulted in his decision to reduce the C-17 Program buy from 210 to 120 aircraft to support a strategic airlift requirement of 48-million ton-miles per day (MTM/D). The MTM/D was the primary factor used to determine the size of the airlift fleet needed. Subsequently, in January 1992, the

congressionally mandated MRS^{1/} identified a FY 1999 baseline strategic airlift requirement of 57 MTM/D. However, after the remaining 152 C-141 primary authorized aircraft (PAA) are retired, a 5-MTM/D shortfall would exist, which translates to an additional 34 C-17 PAA or 40 total aircraft inventory.^{2/}

Payload. In March 1991, the Air Force agreed to payload reductions with Douglas as part of the negotiation of the Lot III contract. Douglas' original winning proposal was to carry 172,200 pounds for 2,400 nautical miles. After contract award, these numbers became the contract-specified requirement. During negotiations for an OSD-directed postcontract engineering change proposal, the Military Airlift Command (MAC) traded about 5,200 pounds of maximum cargo capability to gain a four-pallet ramp and the Onboard Inert Gas Generating System. The maximum designed payload remained at 172,200 pounds, but the range slipped below 2,400 nautical miles for this weight. As a result of Lot III negotiations, the new contract-specified maximum payload for 2,400 nautical miles was reduced to 160,000 pounds.^{3/} Below is a detailed listing of tradeoffs between payload and range.

o The maximum payload mission remained at 172,200 pounds, but for a mission of 2,400 nautical miles unrefueled, it was decreased to 160,000 pounds.

^{1/} The mobility requirement recommended by the MRS is fiscally constrained. This represents a sharp break with the past practice of defining military requirements without considering costs, then proposing programs that fall short of meeting the requirement, and calling the shortfall risk. The MRS states that its requirement will provide a mobility program adequate to meet with moderate risk the Nation's needs in the uncertain world of the 1990's. In our opinion, the MRS should have used the unconstrained low-risk requirement and measured the resulting shortfall to the fiscally constrained goal.

^{2/} The total aircraft inventory equals 117 percent of PAA, which is used to measure operational requirements. The additional 17 percent is comprised of training aircraft (7 percent) and backup aircraft inventory (10 percent). Therefore, 34 C-17 PAA equals 40 total aircraft inventory and 152 C-141 PAA equals 178 total aircraft inventory.

^{3/} The requirement was incrementally reduced from 172,200 to 160,000 pounds. There were three adjustments in the unrefueled maximum payload requirement between the original contract and the change negotiated in March 1991 in conjunction with the Lot III award.

o The heavy logistics missions of 2,700 and 3,200 nautical miles unrefueled carrying payloads of 153,297 and 134,562 pounds, respectively, was reduced to 150,000 and 130,000 pounds, respectively.

o The intertheater logistics mission of 2,800 nautical miles unrefueled with a payload of 124,039 pounds was reduced to 120,000 pounds.

o The high performance logistics mission of 500 nautical miles unrefueled in both directions was reduced from 81,140 to 75,000 pounds.

o The unrefueled ferry range with no payload was reduced from 4,915 to 4,600 nautical miles.

The Air Force Chief of Staff directed requirements study in 1989 verified that the U.S. Army's maximum loads for the C-17 will weigh 160,000 pounds or less.

Delivery. The delivery dates have slipped for T-1 and the first five production aircraft. T-1 first flight, which was originally scheduled for February 1990, occurred in September 1991. Delivery of the first production aircraft was scheduled for December 1991; however, as of May 6, 1992, the delivery had not occurred. The planned delivery schedule has been affected by a number of factors that are likely to increase program costs and could affect the retirement schedule for the C-141 aircraft. As of October 1991, the C-17 Program Director estimated that the Initial Operational Capability, delivery of the 12th production aircraft, would slip from September 1992 to September 1994. In addition, decreases in the annual buy rate can significantly extend delivery schedules as well as increase the unit and program cost of the C-17 Program. For example, the continued affordability of procuring 18 aircraft per year in view of DoD budget reductions may need to be revisited.

Unit cost. As a result of reducing the C-17 aircraft buy from 210 to 120 aircraft, the MAR precipitated a program acquisition unit cost (PAUC) increase of over 25 percent, resulting in a Nunn-McCurdy^{4/} unit cost breach. For the

^{4/} For each system that experiences more than a 25-percent breach of its unit cost threshold, the Secretary of Defense must certify the program to Congress. As part of this certification, ASD(PA&E) must recommend, in coordination with the Director, Defense Research and Engineering, whether the program is essential to the national security and whether there are alternatives that would provide equal or greater military capability at less cost.

"C-17 Selected Acquisition Reports" in December 1989 and September 1990, the PAUC (in then-year dollars) was about \$199 million and \$261 million, respectively, for an increase of about \$62 million (31 percent). The "Defense Acquisition Executive Summary," January 25, 1992, identified a PAUC of about \$295 million. In addition to the PAUC increase, the unit cost for the C-17 production lot buys may increase. On July 25, 1991, a Lot III production contract was awarded to acquire four additional aircraft for a target price of \$1.03 billion, or about \$258 million per aircraft. The Lot IV production buy for four aircraft is scheduled for August 1992. The FY 1992 Department of Defense Appropriations Act provides about \$1.53 billion, including Government-furnished equipment (GFE), for the Lot IV buy or about \$381 million per aircraft. The advance procurement and spare parts funding for Lot IV is about \$122 million and about \$126 million, respectively. Further, the Air Force is determining the impact of congressional reductions in the FY 1992 buy on the overall cost of the C-17 Program.

Air Force Cost-Effectiveness Assessment

The Air Force did not perform a COEA because it was convinced that the C-17 was cost-effective under any scenario. This conclusion was supported by the March 1987 GAO report, the April 1990 Secretary of Defense MAR, the March 1991 ASD(PA&E) analysis, and the 1986 through 1991 MAC airfield analyses. In the cost analyses performed, the C-141 SLEP was considered as an alternative for, rather than a complement to, the C-17 aircraft.

GAO Report. GAO Audit Report No. GAO/NSIAD-87-97 (OSD Case No. 7197), "Military Airlift: Air Force Analysis Supports Acquisition of C-17 Aircraft," March 20, 1987, concluded that, assuming the C-17 closely meets its cost and performance objectives and is used for routine direct delivery in wartime, the aircraft should provide overall advantages to the Air Force over the C-5, including lower life-cycle costs. The report was based on a 210-aircraft buy and a 66-MTM/D strategic airlift capability goal established by the Air Force in 1983 (Appendix B).

Major Aircraft Review. During the MAR, the Secretary of Defense selected the C-17 alternative over two non-C-17 alternatives (Appendix C): maintaining current C-5 and C-141 force, performing a C-141 SLEP, procuring 244 (212 PAA) C-130's, and procuring a new airlifter (C-X) in the future; and procuring 208 (180 PAA) additional C-5 and 244 (212 PAA) C-130 aircraft and retiring the C-141 fleet. However, the C-17 alternative had five variations with C-17 buy quantities ranging from 118 to 257 aircraft. The five C-17 variations included four options for other aircraft types including retiring or extending the service life of all 270 C-141 aircraft, retiring 83 C-130 aircraft or buying 244 C-130 aircraft, starting a C-X coinciding with

two SLEP cases, and keeping the C-5 fleet "as is." Further, the three alternatives, including the five variations, used throughput goals at three levels: 48-MTM/D, 60-MTM/D, and 66-MTM/D. The C-17 alternative that the Secretary of Defense chose reduced the C-17 buy from 210 to 120 aircraft and simultaneously reduced the strategic airlift capability goal from 66- to 48-MTM/D. The reduction was driven by anticipated reductions in DoD budgets and a reduction in the multitheater global war threat. At a \$116 billion (FY 1990 dollars) life-cycle cost, the C-17 alternative to purchase 118 aircraft (100 PAA) at the 48-MTM/D level was the most cost-effective. The only other alternative with a 48-MTM/D goal (which included a C-141 SLEP and procurement of 212 C-130's and a C-X starting in FY 2004) had a life-cycle cost of \$164 billion. Given the alternatives, the Secretary of Defense chose the 120-aircraft C-17 Program. However, the 120-aircraft buy and the 48-MTM/D was not the Air Force's preferred alternative. "The U.S. Air Force Airlift Master Plan," September 29, 1983, established 66-MTM/D as the strategic airlift capability goal. Since the time the MAR was completed, the Secretary of Defense has again revised the strategic airlift capability goal and has established the 48-MTM/D as the lowest limit rather than the goal.

Assistant Secretary of Defense (Program Analysis and Evaluation) analysis. The ASD(PA&E) analysis (Appendix D) also supported the procurement of the C-17. On March 5, 1991, the ASD(PA&E) conducted a cost-effectiveness analysis of the C-17, which included three alternatives similar to those in the MAR, but with four major differences. The three alternatives were: procure 120 C-17's and retire the C-141's; cancel the C-17 Program, perform a SLEP for the C-141 followed by a replacement aircraft program with research and development beginning in FY 2004 and procurement between FY 2007 and FY 2016, and procure 136 additional C-130's by FY 2000; and cancel the C-17 Program, procure 120 C-5's in place of C-17's, retire the C-141's, and procure 136 C-130's. In each option, the current C-5 fleet of 109 primary authorized aircraft was retained. The four major differences were: the C-17 alternative was the Secretary of Defense's 120-aircraft C-17 Program, with no variations as in the MAR; the throughput was fixed at the Secretary of Defense's 48-MTM/D floor for all three alternatives; the C-5 alternative was to procure 120 aircraft based on 48-MTM/D, versus 208 aircraft for 66-MTM/D in the MAR; and the costs of the alternatives were compared in terms of cost per throughput (ton-miles per day) versus total program costs in the MAR. The analysis concluded that:

Without constraints the C-5 and C-17 options are roughly equivalent in terms of cost effectiveness. The C-141 SLEP, with development of a future replacement, is only competitive with the other

two options if costs are discounted. As constraints are added, the C-17 always becomes the option of choice. As the United States moves into an era where it finds itself more likely to be concerned with various regional scenarios rather than a major deployment in central Europe, the impact of airfield constraints will be more important in our deployment planning. Accordingly, the benefit of the C-17 in constrained situations will be more important. These conclusions hold for the range of cost assumptions within each option.

The Air Force did not conduct a COEA to support either the MAR or the Lot III production decision but instead provided the information requested by the parties conducting these various reviews.

Military Airlift Command airfield analyses. One of the critical determinants in the cost-effectiveness of the C-17 is the projected capability to operate into and out of small, austere airfields. "Airlift Operations Review," January 1981, defines a type B small, austere airfield as being 3,000 by 90 feet; having a runway surface capable of accommodating C-130, C-5, and C-X aircraft (that is, load classification group IV); having a ramp of 300 by 250 feet; and having a single 50-foot taxiway from runway center to ramp. The C-17 facilitates such operations with features such as the ability to land on a 3000-foot runway with a 160,000 pound payload; take-off from a 3000-foot runway with a 75,000 pound payload; turn around on a 90-foot wide runway versus the 150-foot runway required for the C-141 and C-5; back up a 1.5-percent grade, reducing space needed to park or turn around; and carry outsize cargo over intertheater ranges into austere airfields, thereby introducing a direct deployment capability that would significantly improve airlift responsiveness. The Air Force contrasted the C-5's capabilities to the C-17's in "Airlift and U.S. National Security: The Case for the C-17," 1991, as follows.

The C-5, on the other hand was designed with a high lift wing to land on shorter runways and high flotation landing gear to operate on runways with lower strengths. But years of operational experience with the C-5 demonstrated that just takeoff/landing performance and high flotation landing gear - the major specifications that C-5 designers worked under in developing the system - did not permit the Military Airlift Command to employ smaller, more austere airfields on a routine basis.

Airfield analyses in four MAC-generated documents indicated that more airfields were available to the C-17 than the C-5 or C-141.

- o "The Case for the C-17, the Operator's View," January 1986, contained a table that showed that 6,399 more airfields were available to the C-17 than the C-5 and C-141. This analysis included airfields in the free world, excluding the United States; used MAC criteria of a 3,000- by 90-foot runway for the C-17 and 5,000- by 90-foot runway for the C-5 and the C-141; and did not consider load classification number (LCN), which denotes runway strength.

- o "C-17 Production: The Operator's View," October 1986, stated that "The C-17's ability to routinely operate into 3000-foot airstrips provides our strategic airlift force access to 6,399 additional airfields worldwide" This document used the same airfield and aircraft criteria as the "The Case for the C-17, the Operator's View," January 1986.

- o In 1989, MAC prepared an airfield analysis for the Air Force Chief Of Staff Requirements Review that showed 5,682 airfields in the free world, excluding the United States, with an LCN of 20 or greater. The MAC used an LCN of 20 because it represented a conservative estimate of the capability of the C-17 or C-5 to land on a runway from 300 to 3,000 times without severely damaging the runway. Using MAC runway length and width criteria from "The Case for the C-17, the Operator's View," January 1986, we calculated that only 1,612 more runways were available to the C-17 than the C-5.

- o "Airlift and U.S. National Security: The Case for the C-17," 1991, stated that "three times as many airfields are open to the C-17 on a routine basis as are available to the C-5 and C-141, even on a contingency basis." This document used the same airfield and aircraft criteria as "The Case for the C-17, the Operator's View," January 1986. A bar chart in the 1991 document showed that approximately 10,000 airfields were available to the C-17 versus 3,500 for the C-5 and C-141. The difference amounted to about a 6,500 airfield advantage for the C-17.

Our analysis of a variety of airfield LCN, length, and width data provided by the Air Force and the Defense Mapping Agency, shows that the C-17 would be able to land at more airfields than the C-5. However, as the airfield LCN increases, the C-17 airfield advantage decreases because runways with higher LCNs tend to be at least 5,000 feet long and thus able to accommodate the C-5 and C-141 during contingency operations (Appendix E). The results of our analysis parallel those in the March 1991 ASD(PA&E) analysis that the C-17 is most effective when a requirement exists to operate into constrained airfields; however, as the constraints are relaxed, the advantages of the C-17 diminish. The C-5 was

also intended to operate into and out of shorter airfields when it was originally designed, yet the Air Force imposed subsequent limitations on such use for operational considerations. Further, the high flotation feature of the C-5 aircraft compared to the C-17 aircraft did not alter our conclusion that the C-17 was more capable than the C-5 of operating into and out of austere airfields.

Defense Acquisition Board Program Review Needed

We consider a special DAB program review of the C-17 Program as essential before award of the Lot V production contract, scheduled for March 1993. This contract award is planned to total 8 aircraft, which, when combined with the 14 already on contract or authorized, will total 22 aircraft (about 18 percent of the 120-aircraft C-17 Program).

C-17 Buys through Lot VI

<u>Lot</u>	<u>Award Date</u>	<u>Units</u>	<u>Cumulative</u>	<u>Ceiling (in Millions of Then-Year \$)</u>	<u>Percent of 120 Units</u>
I	Jan. 1988	2	2	\$ 746.5	1.67
II	July 1989	4	6	\$ 930.8	5.00
III	July 1991	4	10	\$1,215.1	8.33
IV	Aug. 1992	4	14	\$1,811.6 ^{1/}	11.70
V	Mar. 1993	8	22	\$2,898.7 ^{1/}	18.33
VI	FY 1994 ^{2/}	12	34	\$3,976.6 ^{1/}	28.33

^{1/} "C-17 Selected Acquisition Report," December 31, 1991.

^{2/} Specific month was not available.

This significant level of commitment to the C-17 Program before a Milestone III Production and Deployment decision and completion of operational test and evaluation requires DAB level oversight. The amount of time until the March 1993 Lot V award will provide the Air Force the ability to complete a formal COEA and the other pertinent DAB documentation. By March 1993, the Air Force should complete additional testing of the C-17 aircraft as well as numerous systems engineering management reviews, such as the functional and physical configuration audits that will confirm the production aircraft configuration. These events will ensure that the objectives predicted for C-17 performance are achievable, thus providing for a more accurate assessment of cost and operational effectiveness than use of estimates for such parameters as range and payload.

Further, we consider the current schedule of conducting the DAB Milestone III Production and Deployment decision in March 1995, which immediately precedes the Initial Operational Capability of

the C-17, to be essentially too late to assess the most cost-effective combination of C-17 and other airlift aircraft to satisfy airlift mission area requirements established by the MRS, and to establish thresholds for the C-17 Program to be evaluated as part of the Milestone III review.

At Milestone III, scheduled for March 1995, 34 aircraft, estimated to cost about \$11.6 billion, will be on contract and the Air Force will be requesting approval to proceed with full-rate production of 18 aircraft, annually. Substantial long-lead funding will also be obligated and expended on subsequent production lots. This compares sharply with 14 aircraft on contract prior to the Lot V award at a cost of about \$4.7 billion. Therefore, we consider this level of commitment to the C-17 Program, planned prior to the Milestone III review, to be extraordinarily high and excessively late to assess the best mix of airlift assets. Also, it further delays necessary actions to permit the continued viability of the C-141 SLEP alternative. The DAB should rely in part on the results of the Air Force COEA, and the ASD(PA&E)'s and the Joint Requirements Oversight Council's assessment of the COEA as support of the DAB review of C-17 Lot V production contract. Further, ASD(PA&E) should perform an affordability assessment of the C-17 Program's production rate in support of the recommended DAB review to evaluate the realism of forecasted outyear production buys.

The Assistant Secretary of the Air Force (Acquisition) should direct the preparation of DAB documentation for the C-17 Program. DoD 5000.2-M discusses documentation submitted in support of a milestone review by the Program Manager and the Program Manager's Component, including the Integrated Program Summary with annexes and stand-alone documents. The Integrated Program Summary with annexes and stand-alone documents provides information that enables the milestone decision authority to make a production decision based on a program's status and readiness to continue ahead in the acquisition cycle.

The "National Defense Authorization Act for Fiscal Years 1992 and 1993, Conference Report," November 13, 1991, imposed the following limitations on C-17 Lot V production funds.

None of the funds appropriated for the Department of Defense for fiscal year 1993 that are made available for the C-17 aircraft program (other than funds for advance procurement) may be obligated before (1) the Air Force has accepted delivery of the fifth production aircraft under that program; and (2) the Director of Operational Test and Evaluation of the Department of Defense (A) has evaluated the performance of the C-17 aircraft with

respect to critical operational issues after the first 50 flight hours of flight testing conducted during initial operational testing and evaluation of the aircraft; and (B) has provided to the Secretary of Defense and to the congressional defense committees an early operational assessment of the aircraft regarding both the aircraft's overall suitability and deficiencies in the aircraft relative to (i) the initial requirements and specifications for the aircraft, and (ii) the current requirements and specifications for the aircraft.

These limitations further support the need for a DAB program review before award of the Lot V production contract and parallel our recommendations.

On July 19, 1991, the Committee directed that the Chairman of the Joint Chiefs of Staff perform a cost-effectiveness analysis of the C-17 Program. To the extent this analysis considers a complementary mix of C-17 and C-141 SLEP aircraft that meets MRS requirements and complies with DoD Instruction 5000.2, it will satisfy the need for a COEA without requiring yet another analysis of the C-17 Program. The timing of the Office of the Joint Chiefs of Staff study supports a DAB program review of the Lot V production decision.

C-141 Service-Life Extension Program

The OSD and the Air Force did not consider, as one of the alternatives in their cost analyses, a complementary fleet comprised of C-141 aircraft with a service-life extension to 60,000 hours and a combination of C-17, C-5, and C-130 aircraft. The models used and the analytical methodology did not determine the optimal mix of airlift aircraft required, including C-17, C-5, C-130, C-141 SLEP, KC-10, and Civil Reserve Airlift Fleet aircraft. While the analyses supported the assertion that the C-17 aircraft was cost-effective in the austere airfield scenarios, they did not permit a determination as to what quantity of C-17's is required based on the potential capabilities of a lower cost C-141 SLEP aircraft. The OSD and the Air Force did not consider a complementary fleet alternative because the C-17 was viewed as a replacement for the C-141 in the analyses performed, although the C-17 mission description in the "C-17 Selected Acquisition Report," December 31, 1990, stated that the C-17 will augment the existing fleet of C-5's and C-141's. Part of the problem with consideration of the SLEP was that the analyses fixed the aircraft inventory objectives rather than determining them. The Air Force justified continuation of

the C-17 Program based on the operational advantages of the C-17 aircraft and the age of the C-141 fleet, which is nearing the end of its service life. The Air Force may not be able to fulfill the requirements established in the MRS unless either a C-141 SLEP is performed or an additional buy of C-17 aircraft above the 120-aircraft C-17 Program is approved. The MRS does not consider a C-141 SLEP as an alternative to additional C-17 aircraft.

C-141 service life. The C-141's service life was originally 30,000 hours when it was built by the Lockheed-Georgia Company (Lockheed) in the early 1960's. In 1977, the Air Force convened its Scientific Advisory Board (SAB) to determine the feasibility of extending the C-141's service life to 45,000 hours in conjunction with a major modification program to improve the transport's capabilities. After the SAB determined that 45,000 hours was achievable, the Air Force carried out a modification program in the late 1970's and early 1980's to stretch (increase the length of) the airframe, which resulted in increased cargo capacity. The program also added an aerial-refueling capability. The stretch increased the normal weights carried by the aircraft and placed additional strains on the airframe. These strains are expressed in terms of severity factors^{5/} and are tracked over 21 structural zones for the C-141.

After the airframe was stretched, new missions were added in which the aircraft was flown at a low level and was aerial-refueled, which further increased severity factors and caused additional airframe fatigue. High-speed low-level missions and heavy-weight air-refueling missions can result in severity factors of 20 to 25. Conversely, long-range, high-altitude missions can result in severity factors as low as 0.6. The average C-141 severity factor for 1986 through 1989 was 1.44 for the inner-lower wing, the most critical structural tracking zone (zone 7).

Wing cracks. As of September 1991, the C-141 fleet had logged an average of 33,600 hours. However, because of its severe use, wing cracks developed, which, according to criteria established by the SAB, were beyond acceptable risk. Until repairs can be made, the Air Force has restricted aircraft operations to a 1.15 severity factor and has implemented

^{5/} A severity factor is the ratio of time it takes for a crack in a particular area to grow to a given length while flying a certain mission mix, compared to the time it takes while flying a mission mix defined as the baseline. Thus, the baseline mission mix severity factor is one, and the actual severity factor is greater than, equal to, or less than one, depending on the mission mix flown.

recurring inspections. The repair program is designed to ensure that the fleet reaches 45,000 hours; but even under this program, the first C-141's are scheduled to retire in FY 1993, and none will have attained 45,000 hours.

To repair the wing cracks, Warner-Robins Air Logistics Center (Warner-Robins) has undertaken an ambitious repair program. However, in order to accomplish this program, Warner-Robins has deferred three programmed depot maintenance (PDM) tasks for 2 years, two of which involve corrosion control. In addition, Warner-Robins had increased the PDM cycle from 3 to 4 years in 1981 and to 5 years in 1989, resulting in less frequent inspections and maintenance of the C-141 fleet. As a result of the PDM task deferral and cycle increase, future maintenance actions to achieve an extended service life could become uneconomical, and the option for a SLEP may not be preserved.

Service-life extension beyond 45,000 hours. "Airlift and U.S. National Security: The Case for the C-17," 1991, concluded that a service-life extension of the C-141 fleet should not exceed 45,000 hours because of airframe rework, technical uncertainties, and the capabilities of the C-141. The Air Force document stated that extending the service life of the C-141 from 45,000 to 60,000 hours would require a major rework of the airframe, including at least a new wing and possibly new engines. The Air Force estimated the cost for the airframe rework and new engines at approximately \$13.5 billion and determined that extensive additional engineering would be required to assess the problems involved. The Air Force contended that significant technical uncertainties were involved in extending the C-141's service life to 60,000 hours, and it has no experience in making an aircraft last that long. While some commercial aircraft have experienced that many hours, they are operated under less severe flight profiles. The Air Force stated that if the service life of the C-141 were extended to 60,000 hours, a significant problem with the aging airframe could occur, resulting in the grounding of the C-141 fleet and loss of their strategic airlift capability. Further, it believed that such a program would not improve the capabilities of the C-141 since the aircraft cannot carry outsize cargo and requires relatively long runways for operation.

Service-life extension to 60,000 hours may be feasible. We discussed the wing cracks, airframe rework, and technical uncertainties with officials from Warner-Robins; representatives of Lockheed; the C-141 Program Integrator from the Lockheed Defense Plant Representative Office; and an Air Force technical expert, who was a member of the SAB convened in 1977 to assess the 45,000-hour service-life extension. They believe that a service-life extension to 60,000 hours is technically possible but would require a rewinging of the aircraft, based on MAC's projected use at 1.7 to 2.0 severity factor as of January 1990.

They did not believe that a wing repair versus replacement option was feasible because of extensive repairs projected, weakening structural integrity, and resulting operational limitations. The MAC subsequently informed us that, as a result of the MAC Council's June 1990 decision, the overall goal for the future was not to exceed a 1.41 average severity factor.

In October 1991, Lockheed estimated that, based on a rewinging of the C-141 and a 60,000-hour service life, the cost for a service-life extension of the C-141 fleet of 261 aircraft would be about \$4.5 billion in FY 1991 dollars, or about \$17 million per aircraft, compared to the C-17 Lot III unit cost of about \$258 million. However, Lockheed noted that, if it were awarded the contract, it would require about 2 years, from the date of contract award, before it could complete a service-life extension for the first aircraft.

Also, in an October 1991 update to the January 1990 estimate by Warner-Robins, we calculated that the cost to extend the service life of 270 C-141's to 60,000 hours, including rewinging, was \$2.4 billion, or about \$9 million per aircraft in FY 1990 dollars. Based on a Warner-Robins February 1990 cost comparison (between Lockheed and Warner-Robins) for a center wing box replacement program, it appears that much of the \$2.1 billion cost difference between the two SLEP estimates can be attributed to Lockheed's higher labor rates. The Lockheed and Warner-Robins estimates are strictly acquisition costs and do not include operation and support costs.

Airlift requirements. A service-life extension of the C-141 may be necessary in order for the Air Force to meet its future strategic airlift requirements. If the C-141 fleet is retired and replaced by the C-17 as planned, MAC may not have enough aircraft to meet its strategic airlift requirements in terms of number of missions. According to MAC, the Air Force plans to maintain a complement of C-141 aircraft for the foreseeable future because of the insufficient quantities of C-17 aircraft to fulfill existing airlift requirements, which may increase. Specifically, the Air Force is planning to retain at least 128 C-141 PAA until FY 2002 (approximately 56 percent of the FY 1992 C-141 fleet) and at least 64 C-141 PAA through FY 2009. However, the Secretary of Defense's decision at the MAR was based on retirement of the entire C-141 fleet, starting in FY 1994, and acquisition of 120 C-17 aircraft to achieve a 48-MTM/D requirement. The MRS projects a FY 1999 baseline strategic airlift requirement of 57 MTM/D. The MRS states that a 5-MTM/D shortfall will result when the remaining 152 C-141 PAA are retired after FY 1999. To satisfy the shortfall and to maintain a medium-confidence capability, the MRS recommends that DoD consider five options; however, a C-141 SLEP is not one of the options. Also, while the MRS identifies an option for additional C-17 aircraft, the Secretary of Defense has not approved going

beyond the 120-aircraft C-17 Program. However, the C-141's may partially or fully meet the need and, in our opinion, significant savings could be realized with this alternative.

Conclusion

The OSD and the Air Force had not conducted a formal COEA after major C-17 Program changes occurred or considered an airlift fleet alternative of C-17's along with C-141's with extended service lives. This occurred because all their analyses, which limited the C-17 versus C-141 SLEP alternatives to all or nothing, supported the cost-effectiveness of the C-17. Also, before the MAR, there was no consideration of a SLEP because 180 C-17 PAA and 180 C-141 PAA would meet the MTM/D requirement. A C-141 service-life extension of at least a portion of the C-141 fleet should be an alternative in the COEA for four reasons: the relatively low cost of the C-141 SLEP versus new C-17 procurement, the delays in fielding the C-17, the future airlift shortfall outlined in the MRS, and the existing facilities and infrastructure supporting the C-141.

RECOMMENDATIONS FOR CORRECTIVE ACTION

1. We recommend that the Under Secretary of Defense for Acquisition:

a. Conduct a special Defense Acquisition Board program review of the C-17 Program to evaluate award of the Lot V production contract.

b. Direct the Air Force to initiate a cost and operational effectiveness analysis of the C-17 Program for assessment by the Assistant Secretary of Defense (Program Analysis and Evaluation) and the Joint Requirements Oversight Council in support of the Defense Acquisition Board review of C-17 Lot V production contract award. The cost and operational effectiveness analysis should incorporate the results of the congressionally mandated Mobility Requirements Study and focus on complementary mixes of C-17 and other airlift aircraft.

c. Request the Assistant Secretary of Defense (Program Analysis and Evaluation) to perform an affordability assessment of the C-17 Program, including a review of the production rate, in support of the recommended Defense Acquisition Board review.

2. We recommend that the Secretary of the Air Force:

a. Convene the Scientific Advisory Board to determine the technical feasibility of a service-life extension program for the C-141 aircraft fleet and review programmed depot maintenance policies and practices for the C-141 fleet.

b. Assess the need for a service-life extension of the C-141 aircraft fleet based on the recommendations of the Scientific Advisory Board, the results of the Mobility Requirements Study, and the cost and operational effectiveness analysis.

c. Limit retirement of any operationally capable C-141 aircraft until a decision is rendered concerning a service-life extension for the C-141 fleet.

3. We recommend that the Assistant Secretary of the Air Force (Acquisition) direct the preparation of documentation in support of the Defense Acquisition Board review of the C-17 Lot V production contract award. Documentation should include, as a minimum, an integrated program summary, an independent cost estimate, a cost and operational effectiveness analysis, a test and evaluation master plan, and an operational test and evaluation report in the format specified in DoD 5000.2-M, "Defense Acquisition Management Documentation and Reports," February 23, 1991.

STATUS OF RECOMMENDATIONS

Number	Addressee	Response Should Cover:			Related Issues*
		Concur/ Nonconcur	Proposed Action	Completion Date	
1.	USD(A)	X	X	X	IC
2.	Secretary of the Air Force	X	X	X	
3.	Assistant Secretary of the Air Force (Acquisition)	X	X	X	IC

* IC equals material internal control weakness.

MANAGEMENT COMMENTS

We received comments from USD(A) and the Assistant Secretary of the Air Force (Acquisition), who also provided comments for the Secretary of the Air Force. The USD(A) nonconcurred with Recommendations 1.a., 1.b., and 1.c., and provided clarifying information and comments on the finding. The Assistant Secretary nonconcurred with Recommendations 2. and 3., and provided other specific comments. Complete comments by USD(A) and the Assistant Secretary are in Part IV of this report.

Regarding Recommendation 1.a., USD(A) stated that several reviews had already occurred and an additional DAB review was not required. The USD(A) also stated that the Joint Staff was currently conducting a cost-effectiveness review directed by Congress and that USD(A) canceled the May 1992 DAB review because of the level of C-17 review and oversight.

Regarding Recommendation 1.b., USD(A) stated that an additional COEA was not needed because the Joint Staff currently was doing one and a decision to maintain an increased level of airlift was not required until 1996. The USD(A) cited the FY 1992 Authorization Act and the MRS to support his contention.

Regarding Recommendation 1.c., USD(A) stated that an affordability assessment was not needed because sufficient analysis has been done, the Joint Staff assessment will provide additional data, and the C-17 Program is fully funded in the budget.

Regarding Recommendation 2., the Assistant Secretary stated that implementing this recommendation would be a duplication of effort of past and ongoing assessments regarding the C-141 SLEP option.

Regarding Recommendation 3., the Assistant Secretary stated that preparing documentation to support a DAB review is unnecessary because a cost-effectiveness study directed by Congress is now underway. He further stated that a COEA is not required by regulation at this stage of the C-17 Program and would duplicate efforts of the ongoing study.

AUDIT RESPONSE TO MANAGEMENT COMMENTS

Comments by USD(A) are not considered responsive because:

- o Neither the prior reviews nor the current review by the Joint Staff were/is based on a valid cost and operational effectiveness analysis, as defined by DoD Instruction 5000.2.

- o Cancellation of the May 1992 DAB review by USD(A) highlights rather than diminishes the need for a special review to evaluate the award of Lot V given the lengthened interval between formal evaluations and the fact that a proper COEA was never done. A review at Milestone III in March 1995 would be too late to assess the most cost-effective combination of airlifters. We strongly disagree that such an assessment of a complementary mix of aircraft is premature. Waiting until 1996 could all but eliminate presently viable alternative aircraft mixes. As demonstrated in our report, the commitment to the C-17 Program by the time of the Milestone III review coupled with the continued degradation of the C-141 fleet would in essence eliminate serious consideration of viable alternatives to procurement of an entire fleet of C-17 aircraft.

o A COEA is needed to determine the number of C-17's, as well as other airlifters, actually needed. None of the prior analyses have done this, and the review by the Joint Staff does not presently include an analysis of alternative mixes of C-17 and C-141 SLEP aircraft as a means to reduce long term airlift costs.

o A decision is required now on the future airlift fleet. The Air Force plans to retire the first C-141's in FY 1993 and a total of 54 by the end of FY 1997. Many more will likely be beyond economical repair by that time. About a 2-year lag is expected from a decision date until the first refurbished C-141 would be ready. To delay a decision to 1996 would likely preclude the C-141 SLEP option and default to additional C-17's. Such a scenario would not be cost-effective if a COEA determined that the correct number of C-17's were less than 120 or if additional airframes were needed, cargo capacity notwithstanding, that could be provided by a C-141 SLEP instead of new procurement of C-17's beyond the 120-aircraft C-17 Program.

o Regardless of the level of current funding, an affordability assessment should be done to evaluate the realism of forecasted outyear production buys in light of decreases in future DoD budgets. The procurement of 18 aircraft per year at full-rate production will be a substantial expenditure of Aircraft Procurement, Air Force, funding for a period of years.

Comments by the Assistant Secretary of the Air Force (Acquisition) are not considered responsive because:

o Our recommendation does not duplicate past and ongoing considerations of the C-141 SLEP option because those assessments presented the SLEP as an all-or-nothing alternative and did not consider a complementary mix of the C-141 SLEP with the C-17. Further, during our audit, we were repeatedly told by Air Force officials that the SLEP was a "dead issue" because of the potential consequences of serious consideration of a C-141 SLEP on the C-17 Program. The main reason we included a recommendation to convene the SAB was to obtain a more objective view on the issue. In addition, none of the assessments recommended convening the SAB to determine the technical feasibility of a SLEP and review PDM policies and practices for the C-141 fleet, which we believe are detrimental to preserving the SLEP option.

o DoD Instruction 5000.2 requires a COEA at the Milestone II decision point that can be updated at the Milestone III production and deployment decision point. Since no COEA was done at Milestone II, and given the commitment in terms of the number of aircraft on contract by Milestone III, a COEA

should be performed as soon as possible. The date of DoD Instruction 5000.2 notwithstanding, the requirement is valid now. A proper COEA would not be a duplication of effort because one has not been done.

The C-17 is currently undergoing substantial testing that will also provide valuable information for the DAB to assess in conjunction with the COEA prior to further major production commitments in the form of award of the Lot V contract. It is too late to wait until March 1995, just prior to commencing full-rate production, to consider alternative mixes of airlift aircraft to meet mission requirements. We consider the points raised by both USD(A) and the Assistant Secretary concerning reliance on the ongoing Office of the Joint Chiefs of Staff analysis of the cost-effectiveness of the C-17 Program to be a potentially viable means to assess a complementary mix of C-17 and C-141 SLEP aircraft. Our understanding is that a complementary alternative is not presently being considered in the analysis by the Joint Staff; however, if this alternative were added and adequately evaluated, it would fulfill the intent of our recommendation concerning a COEA.

Our more detailed response to management comments by USD(A) and the Assistant Secretary on the factual content of the draft report is in Part IV of this report.

PART III - ADDITIONAL INFORMATION

- Appendix A - Results of Senate Armed Services Committee Tasking
- Appendix B - Prior Audits and Other Reviews
- Appendix C - Airlift Fleet Alternatives and Costs Per the
Major Aircraft Review
- Appendix D - Airlift Fleet Alternatives and Costs Per the
Assistant Secretary of Defense (Program Analysis
and Evaluation) Analysis
- Appendix E - Airfield Analysis
- Appendix F - Summary of Potential Benefits Resulting From Audit
- Appendix G - Activities Visited or Contacted
- Appendix H - Report Distribution

APPENDIX A: RESULTS OF SENATE ARMED SERVICES COMMITTEE TASKING

In the "National Defense Authorization Act for Fiscal Years 1992 and 1993 Report," July 19, 1991, the Senate Armed Services Committee (Committee) directed our audit of the cost-effectiveness of the C-17 aircraft. The Committee requested that the Inspector General, DoD:

- o Review DoD and Air Force life-cycle cost and performance analyses, and provide an independent assessment of whether these analyses are still valid, paying particular attention to changes in major specifications, such as weight, fuel consumption, cargo capacity, and maximum range.

- o Analyze the validity of the models used to make the effectiveness calculations and the reasonableness of the scenarios used in the models.

Validity of life-cycle cost and performance analyses. The OSD and the Air Force conducted cost analyses of the C-17 Program. In our opinion, their analyses were adequate for their intended purpose, which was to evaluate alternatives to the C-17 Program. However, these analyses were not COEAs as defined by DoD Instruction 5000.2, and DoD 5000.2-M. (DoD Instruction 5000.2, part 4, discusses policies and procedures for developing COEAs to support milestone decision reviews, and DoD Manual 5000.2-M, part 8, provides general procedures and guidelines to develop a COEA.) For example, the analyses performed did not include multiple measures of effectiveness or sensitivity and uncertainty analysis, as now required. All the Government analyses identified during our audit supported continuation of the C-17 Program based on its cost and performance compared to numerous combinations of other viable alternatives at various levels of strategic airlift capability. The C-17 alternative was clearly advantageous in all cases, although the relative advantage compared to other alternatives varied.

The results of these analyses supporting the C-17 Program continue to be valid even if underlying assumptions vary materially beyond the current projections. However, we consider it essential that the Air Force perform a COEA to determine the optimal mix of airlift aircraft that should comprise the fleet based on the results of the MRS and establish cost and performance thresholds for the C-17 Program.

APPENDIX A: RESULTS OF SENATE ARMED SERVICES COMMITTEE TASKING
(cont'd)

Validity of the models. We concluded that the models used by OSD and the Air Force for assessing alternatives to the C-17 Program were valid. The scenarios used in the models, including those based on Operation Desert Storm, were reasonable. The effectiveness calculations in the Air Force and OSD models were performed using the spreadsheet approach with MTM/D as the single parameter for measure of effectiveness. We concluded MTM/D is a valid measure of effectiveness for airlift analyses. The OSD analysis used a spreadsheet approach in the cost-effectiveness model to estimate life-cycle costs over 30 years for three alternatives. The analysis used throughput in MTM/D as the primary measure of effectiveness for mission accomplishment. Within the scenarios presented, airfield constraints such as ramp space and runway length/width were factors in determining throughput. The analysis was performed under three levels of ramp space constraints, and the C-17 alternative was found to be advantageous over the other alternatives. The MAC analysis was prepared in conjunction with the GAO Audit Report No. GAO/NSIAD-87-97 (OSD Case No. 7197), "Military Airlift: Air Force Analysis Supports Acquisition of C-17 Aircraft," March 20, 1987 (Appendix B). The cost analysis compared a C-5 alternative with a C-17 alternative, using a spreadsheet model. The model estimated the operating and support costs for each type of aircraft by including the personnel, fuel consumption, and maintenance costs derived from a series of in-house models developed and maintained by MAC. The acquisition costs for the C-17 were estimated as single point estimates over a 30-year life-cycle period.

Since probability distributions were not used in either analysis, there was no provision for uncertainty analysis, and the values of the variables in the models were estimated as single numbers using basic arithmetic, such as averages. While it is reasonable to assume variation in such values, we found that the key values, which could have a significant affect on the final results or invalidate the analyses performed were unlikely to vary to the extent that the continuation of the C-17 Program should be reassessed. Nevertheless, in our opinion, a COEA should be performed to establish the optional number of C-17's and other aircraft to meet future airlift needs as outlined in the MRS.

APPENDIX B - PRIOR AUDITS AND OTHER REVIEWS

Since 1986, one report has been issued addressing issues similar to those in this audit report. Specifically, GAO Audit Report No. GAO/NSIAD-87-97 (OSD Case No. 7197), "Military Airlift: Air Force Analysis Supports Acquisition of C-17 Aircraft," March 20, 1987, was issued in response to a request by the Chairman, House Committee on Armed Services, to review the Air Force's analysis leading to the decision to buy the C-17 aircraft.

The GAO report concluded that, assuming the C-17 closely meets its cost and performance objectives and is used for routine direct delivery in wartime, the aircraft should provide overall advantages to the Air Force over the C-5, including lower life-cycle costs. However, to reach the established airlift goal, which at the time of the report was 66-MTM/D, total acquisition and life-cycle costs would likely exceed the amounts estimated by the Air Force, regardless of whether it adopts the C-5 or the C-17 alternative.

The GAO report focused on two major alternative force structures that the Air Force presented in the Airlift Master Plan, the C-5 and the C-17. Principal findings addressed in the GAO report included life-cycle costs, military utility, personnel requirements, increases in capability, and cost estimates.

DoD comments. The DoD agreed with most of the analyses and conclusions presented in the GAO report; however, DoD disagreed with some of the adjustments that GAO made to the Air Force's life-cycle cost analysis. DoD also disagreed with GAO's conclusions that the C-17 wartime utilization rate may be too high. After discussion with DoD, GAO modified its life-cycle cost adjustments on the number of C-130's to be retired and replaced under the C-5 alternative. However, GAO believed that its life-cycle cost adjustments were valid and that the C-17 surge utilization rate may be too high.

Lockheed comments. Lockheed believed that the number of aircraft to be acquired under the C-5 alternative could be reduced because the average payload of the C-5 had been understated by the Air Force. The purported understatement, coupled with Lockheed's belief that the operating and support costs for the C-5 have been overstated by the Air Force, would result in a significantly lower life-cycle cost for the C-5 alternative. Additionally, Lockheed believed that the operational utility associated with direct delivery by the Air Force is overstated.

APPENDIX B - PRIOR AUDITS AND OTHER REVIEWS (cont'd)

The GAO report evaluated these issues and discussed them; however, GAO believed that:

- o the direct delivery concept could be militarily significant,

- o the average payload for the C-5 had been only slightly understated and would not significantly affect the number of C-5's to be acquired, and

- o the C-17 alternative should provide lower life-cycle costs over the C-5 alternative.

McDonnell Douglas comments. McDonnell Douglas agreed with the conclusions contained in the GAO report.

APPENDIX C: AIRLIFT FLEET ALTERNATIVES AND COSTS PER THE MAJOR AIRCRAFT REVIEW 1/

Alternative	C-17	C-141	C-5	C-130	Start C-X	Million Ton-Miles Per Day	Six-Year Defense Plan	Acquisition Cost	Life- Cycle Cost	Present Value
1	Cancel	SLEP	As Is	Buy 212	FY 2004	48	\$38	\$47	\$164	\$52
2a 2/	Buy 100	Retire	As Is	Buy 94	N/A	48	42	25	116	48
2b	Buy 180	Retire	As Is	As Is	N/A	60	45	31	130	52
2c	Buy 220	Retire	As Is	Retire 72	N/A	66	45	35	137	54
2d	Buy 180	SLEP	As Is	As Is	FY 2021	66	52	36	156	60
2e	Buy 120	SLEP	As Is	Buy 70	FY 2004	66	58	65	200	69
3	Cancel	SLEP	Buy 180	Buy 212	FY 2021	66	46	32	166	59

1/ The alternatives do not present a range of airfield constraints. The quantities associated with the alternatives represent primary authorized aircraft. Costs are in billions of FY 1990 dollars.

2/ This alternative was chosen by the Secretary of Defense.

APPENDIX D: AIRLIFT FLEET ALTERNATIVES AND COSTS PER THE ASSISTANT SECRETARY OF DEFENSE (PROGRAM ANALYSIS AND EVALUATION) ANALYSIS 1/

	C-17 2/		C-141 SLEP 3/		C-5 4/	
	Low	High	Re-engine	No Re-engine	C-5B	C-5C
	Estimate	Estimate				
No Infrastructure Constraints						
Life-Cycle Cost	\$5.6	\$5.7	\$8.4	\$8.2	\$6.0	\$6.2
Present Value of Life-Cycle Cost	2.3	2.3	2.7	2.4	2.3	2.4
Moderate Infrastructure Constraints						
Life-Cycle Cost	5.6	5.7	9.9	9.6	7.9	8.1
Present Value of Life-Cycle Cost	2.3	2.3	3.1	2.9	3.0	3.2
Severe Infrastructure Constraints						
Life-Cycle Cost	8.7	8.9	23.5	22.8	18.7	19.4
Present Value of Life-Cycle Cost	3.5	3.6	7.4	6.8	7.1	7.6

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1/ Costs are per unit of throughput (thousand dollars per ton-mile per day in FY 1990 dollars) and are based on a 2,000-mile mission. Present value of life-cycle costs are discounted at 10 percent.

2/ Procure 120 (102 PAA) C-17's and begin retirement of C-141 fleet (the alternative chosen by the Secretary of Defense).

3/ Cancel C-17, perform SLEP for C-141, procure 136 (117 PAA) C-130's, and start a C-X program in FY 2004.

4/ Cancel C-17, procure 120 (102 PAA) C-5C's (C-5B's with upgraded avionics), begin retirement of C-141's, and procure 136 (117 PAA) C-130's.

APPENDIX E: AIRFIELD ANALYSIS

(Free World Excluding the U.S.)

<u>Aircraft</u>	<u>Runway (feet) Length x Width</u>	<u>Load Classification Number</u>	<u>Number of Airfields</u>
C-17	>3,000 x >90	0 - Infinity ^{1/}	9,938
C-5	≥5,000 x ≥90	0 - Infinity	4,158
			<u>5,780</u> ^{2/}
C-17	>3,000 x >90	20 - Infinity ^{3/}	4,448
C-5	≥5,000 x ≥90	20 - Infinity	3,118
			<u>1,330</u> ^{2/}
C-17	>3,000 x >90	44 - Infinity ^{4/}	1,945
C-5	≥5,000 x ≥90	44 - Infinity	1,799
			<u>146</u> ^{2/}
C-17	>3,000 x >90	72 - Infinity ^{5/}	1,084
C-5	≥5,000 x ≥90	72 - Infinity	1,056
			<u>28</u> ^{1/}

Notes:

1/ Includes unknown Load Classification Numbers, criteria used by MAC in 1986 and 1991 analyses.

2/ Additional airfields available to the C-17.

3/ Criteria used by MAC for the 1989 Air Force Chief of Staff Requirements Review. An airfield with a Load Classification Number of 20 is capable of sustaining 6 to 9 months of normal use by either a C-17 or C-5 (Defense Mapping Agency criteria).

4/ Rigid (concrete) runway (Defense Mapping Agency rule of thumb).

5/ Unlimited use by either C-17 or C-5 at any gross weight (Defense Mapping Agency rule of thumb).

APPENDIX F: SUMMARY OF POTENTIAL BENEFITS RESULTING FROM AUDIT

<u>Recommendation Reference</u>	<u>Description of Benefit</u>	<u>Type of Benefit</u>
1.a.	Program results. Convening of a special DAB program review of the C-17 Program to evaluate the award of the Lot V production contract will determine the future direction of the C-17 Program.	Nonmonetary.
1.b.	Program results. Directing the Air Force to promptly initiate a COEA of the C-17 Program for assessment in support of the DAB review of C-17 Lot V production contract will determine if the present structure of the C-17 and other airlift programs are cost-effective.	Nonmonetary.
1.c.	Program results. Requesting the per- formance of an afford- ability assessment of the C-17 Program's production rate in support of the recommended DAB review will determine the adequacy of the COEA submitted in support of the review.	Undeterminable.
2.a.	Program results. Convening the SAB to determine the feasibility	Nonmonetary.

APPENDIX F: SUMMARY OF POTENTIAL BENEFITS RESULTING FROM AUDIT
(cont'd)

<u>Recommendation Reference</u>	<u>Description of Benefit</u>	<u>Type of Benefit</u>
	of a SLEP for the C-141 aircraft fleet, including C-141 depot maintenance policies and practices will ensure that the SLEP alternative is given thorough examination.	
2.b.	Program results. Assessing the need to perform a SLEP for the C-141 aircraft fleet based on the recommendations of the SAB and the MRS, and proceeding accordingly will use the C-141 fleet in the most cost-effective manner.	Undeterminable.
2.c.	Program results. Limiting the retirement of any operationally capable C-141 aircraft until a decision is rendered concerning a SLEP would ensure that C-141 aircraft required for the SLEP are not retired prematurely.	Nonmonetary.
3.	Program results. Directing the preparation of documentation for the DAB review of the C-17 Lot V production contract award will ensure proper support exists for DAB decisions.	Nonmonetary.

APPENDIX G: ACTIVITIES VISITED OR CONTACTED

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition, Washington, DC
Assistant Secretary of Defense (Program Analysis and
Evaluation), Washington, DC
Comptroller of the Department of Defense, Washington, DC
Deputy Director, Tactical Warfare Programs, Office of Director,
Defense Research and Engineering, Washington, DC
Deputy Director, Defense System Procurement Strategies, Office of
the Director of Defense Procurement, Washington, DC

Department of the Army

Deputy Chief of Staff for Logistics, Office of the Army Staff,
Washington, DC

Department of the Air Force

Assistant Secretary of the Air Force (Acquisition), Washington,
DC
Headquarters, Air Force Systems Command, Wright-Patterson
Air Force Base, OH
Headquarters, Air Force Logistics Command, Wright-Patterson
Air Force Base, OH
Headquarters, Military Airlift Command, Scott Air Force Base, IL
Headquarters, Warner-Robins Air Logistics Center, Robins
Air Force Base, GA
Air Force Cost Analysis Agency, Washington, DC
Air Force Safety Agency, Norton Air Force Base, CA
C-17 Program Office, Aeronautical Systems Division, Wright-
Patterson Air Force Base, OH

Other DoD Organizations

Joint Staff, Washington, DC
Defense Mapping Agency Aeronautical Center, St. Louis, MO
Defense Plant Representative Office, Douglas Aircraft Company,
Long Beach, CA
Defense Plant Representative Office, Lockheed-Georgia Company,
Marietta, GA

Non-DoD Federal Organizations

Senate Committee on Armed Services, Washington, DC

Non-Government Activities

Lockheed-Georgia Company, Marietta, GA
Douglas Aircraft Company, Long Beach, CA

APPENDIX H: REPORT DISTRIBUTION

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition
Assistant Secretary of Defense (Program Analysis and Evaluation)
Comptroller of the Department of Defense
Director of Defense Procurement
Director, Defense Research and Engineering

Department of the Air Force

Secretary of the Air Force
Assistant Secretary of the Air Force (Acquisition)
Assistant Secretary of the Air Force (Financial Management and
Comptroller)
Commander, Air Force Systems Command
Commander, Air Force Logistics Command
Commander, Military Airlift Command
Commander, Warner-Robins Air Logistics Center
Program Executive Office, Tactical and Airlift Programs
C-17 System Program Office, Aeronautical Systems Division

Defense Activities

Director, Defense Contract Management Command, Defense Logistics
Agency
Director, Defense Mapping Agency

Other DoD Organizations

The Joint Staff

Non-DoD Federal Organizations

Office of Management and Budget
U.S. General Accounting Office, NSIAD Technical Information
Center

Congressional Committees:

Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Government Affairs
Ranking Minority Member, Senate Committee on Armed Services
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
Ranking Minority Member, House Committee on Appropriations
House Committee on Armed Services
House Committee on Government Operations
House Subcommittee on Legislation and National Security,
Committee on Government Operations

PART IV - MANAGEMENT COMMENTS

Under Secretary of Defense for Acquisition Comments
Assistant Secretary of the Air Force (Acquisition) Comments
Audit Response to Under Secretary of Defense for Acquisition
Comments
Audit Response to Assistant Secretary of the Air Force
(Acquisition) Comments

Under Secretary of Defense for Acquisition Comments



ACQUISITION

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3000

15 APR 1992

MEMORANDUM FOR DEPARTMENT OF DEFENSE INSPECTOR GENERAL

SUBJECT: Draft Audit Report on the Cost-Effectiveness of the Air Force C-17 Program
(Project No. 1AE-5020)

This responds to your February 14, 1992, memorandum requesting comments on the subject draft report. The report contains three recommendations for the Under Secretary of Defense for Acquisition.

DoDIG Recommendation 1.A. We recommend that the Under Secretary of Defense for Acquisition conduct a special Defense Acquisition Board program review of the C-17 Program to evaluate award of the Lot V production contract.

Response. Non-concur. An appropriate amount of C-17 review has occurred, and an additional Defense Acquisition Board (DAB) prior to Milestone IIIB (MS-IIIB) is not required.

In January 1989, the Under Secretary of Defense for Acquisition released an Acquisition Decision Memorandum (ADM) documenting the results of the MS-IIIA DAB. The ADM required a DAB program review subsequent to the flight of the first production and test aircraft and prior to the Lot IV contract award. Since the MS-IIIA DAB, there have been three extensive reviews of the C-17 program. These include the Major Aircraft Review in 1990, and the Under Secretary of Defense for Acquisition review and briefing to the Deputy Secretary of Defense in March 1991. In addition, 1992 congressional language requires that the Secretary of Defense submit a report to Congress that includes a Chairman, Joint Chiefs of Staff, certification of the cost effectiveness and military utility. A cost effectiveness review is currently proceeding under the aegis of the Joint Staff. In February 1992, acknowledging the recent level of C-17 review and oversight, the Under Secretary of Defense for Acquisition canceled the proposed May 1992 DAB.

DoDIG Recommendation 1.B. We recommend that the Under Secretary of Defense for Acquisition direct the Air Force to initiate a cost and operational effectiveness analysis of the C-17 Program for assessment by the Assistant Secretary of Defense (Program Analysis and Evaluation) and the Joint Requirements Oversight Council in support of the Defense Acquisition Board review of C-17 Lot V production contract award. The cost and operational effectiveness analysis should incorporate the results of the congressionally-mandated Mobility Requirements Study and focus on complementary mixes of C-17 and other airlift aircraft.

Response. Non-concur. Additional cost and operational effectiveness analysis, beyond current efforts, is not required. Two reasons support this. First, as discussed in the our response to 1.A. above, the Joint Staff, with PA&E and Military Airlift Command participation, is conducting an analysis to support the Chairman's certification of continued

Under Secretary of Defense for Acquisition Comments (Continued)

C-17 cost effectiveness and military utility. This certification will be included in the Secretary of Defense Report to Congress as required by the FY1992 Authorization Act. Second, the Mobility Requirements Study provides that

"after the turn of the century, there will be a significant decline in the total airlift capacity as the last C-141's are retired. . . . in FY2001, the airlift capacity peaks and begins to decline. . . . to the extent that this [increased] level of airlift may be required, the Department of Defense will have to consider a number of options, . . .".

A decision as to whether to maintain an airlift level higher than the present level, and if so by what means, is not required until 1996. Since no requirement now exists to increase the airlift fleet beyond the current level, analysis of complementary mixes of C-17 and other airlift aircraft is premature.

DoDIG Recommendation 1.C. We recommend that the Under Secretary of Defense for Acquisition request the Assistant Secretary of Defense (Program Analysis and Evaluation) to perform an affordability assessment of the C-17 Program, including a review of the production rate, in support of the recommended Defense Acquisition Board review.

Response. Non-concur. Sufficient cost and operational effectiveness analysis has been, and is being, performed to adequately address concerns that the C-17 remains an affordable solution to modernizing our airlift fleet. The ongoing Joint Staff assessment, which includes the latest C-17 performance and cost estimates, will provide additional data. Finally, the C-17 program is fully funded in the Amended President's Budget.

Factual corrections to the report are attached.

Thank you for the opportunity to comment on this draft report.



George R. Schneider
Director
Strategic & Space Systems

Under Secretary of Defense for Acquisition Comments (Continued)

Final Report Reference

ii, para. 2
13, para. 2
Memo, para. 1
3, para. 1
5, para. 1
6, para. 3 & 4
16, para. 1
18, para. 4
19, para. 1 & 2
19, Rec. 1.b.
20, Rec. 2.b.
27, para. 5
28, para. 2
38, Rec. 2.b.

1, para. 1
10, para. 1

1, para. 2

1, para. 2
13, para. 2
13, table
14, para. 3

6, para. 4
10, para. 2

DODIG Draft Audit Report Project 1AE-5020 (February 14, 1992)

Recommendation Factual Corrections

1. Executive Summary, page 2, paragraph 3; page 22, paragraph 2; memorandum page 1, paragraph 1; page 4, paragraph 3; page 7, paragraph 1; page 10, paragraph 1, 2; page 27, paragraph 1; page 32, paragraph 2; page 33, paragraphs 1, 2; page 34, section 1.b.; page 35, section 2.b.; page 39, paragraph 5, page 40, paragraph 2; page 46, section 2.b.

The Mobility Requirements Study (MRS) did not identify that there are mission needs that cannot be met by the 120 aircraft C-17 program alone. The MRS did note an increase in airlift capacity above the current level and then a decrease after 2001 back to the current level. It stated that "to the extent that this [increased] level may be required, the Department will have to consider a number of options...". A decision as to whether to maintain this higher level rather than the current level, and if so by what means, is not required till the preparation of the FY 1998 budget in 1996. Thus a cost-effectiveness analysis of a complementary C-141 service-life extension program was not required in the time period of the audit. Such an analysis might be performed in 1996.

2. Page 1, paragraph 1; page 16.

It is not true the C-17 buy was reduced for budgetary reasons. The Secretary has repeatedly testified that he has not been given an arbitrary budget target, but has recommended to the President only those reductions that were made possible by changes in the threat. In particular about airlift, he stated at the time of the MAR, that we needed less airlift for regional contingencies than for multi-theater global war.

3. Page 2, paragraph 1.

Lot IV is now scheduled to be awarded in August vice April 1992.

4. Page 2, paragraph 1; Page 22, paragraph 2; page 23, table; page 24, paragraph 2.

The lot V contract is for 8 vice 12 aircraft, the total would be 22 vice 26, and the percentage 18% vice 22%. Costs should be adjusted to latest data, too.

5. Page 10, paragraph 1; page 17, paragraph 2.

The MAR did not use MTM/D as its primary factor to determine the size of the airlift fleet. MTM/D was used as a shorthand to describe the alternate fleets, but the requirements analysis was much more detailed, considering aircraft loading, utilization rates, airfield size limitations, etc. MTM/D is a shorthand to describe alternate fleets (much like describing a truck as a 5T truck) but the actual capability will vary with cargo type and destination. By taking account of actual throughput we reach the conclusion that the C-17 option is preferred.

Under Secretary of Defense for Acquisition Comments (Continued)

Final Report Reference

7, para. 1

16, para. 1

7, para. 1

14, para. 2

18, para. 4

19, para. 2

6. Page 10, paragraph 2; page 27, paragraph 1.

The MRS did not identify a requirement of 57 MTM/D. It took the level of aircraft programmed thru FY 1997 as a given, and sized prepositioning to match it. Other combinations of airlift and prepositioning also might meet the requirements. The MRS points out that the planned increase and subsequent decline of capacity is an issue we must address in formulating the FY 1998-02 program in 1996 considering our perception of requirements at the time. Further footnote 1 is incorrect in that the total airlift low risk requirement was noted, but a reduced requirement reflecting moderate risk was established.

7. Page 11, paragraph 1.

The conversion of 34 C-17 PAA to 40 Total Aircraft Inventory (TAI) and associated footnote 2 is incorrect. The TAI is equal to the sum of PAA plus training aircraft plus approximately 54 backup aircraft. The number of training aircraft would probably not be increased if 34 PAA were added, thus 34 PAA might equate to 36 TAI. Similar adjustments might need to be made to the C-141 calculation.

8. Page 24, paragraph 1.

The Milestone IIIB review will be held after IOC.

9. Page 32, paragraph 2.

After the MAR, the Deputy Secretary reviewed and approved the schedule for retirement of C-141s recommended by the Air Force.

10. Page 33, paragraph 2.

Before the MAR, the airlift program was based on the Airlift Master Plan which retained 180 PAA C-141s through 2010. Together with the 180 PAA C-17s and other aircraft, the 66 MTM/D goal would be met without a C-141 SLEP.

Attachment

Assistant Secretary of the Air Force (Acquisition) Comments



DEPARTMENT OF THE AIR FORCE
WASHINGTON, D.C. 20330-1000

OFFICE OF THE ASSISTANT SECRETARY


APR 21 1992

MEMORANDUM FOR ASSISTANT INSPECTOR GENERAL FOR AUDITING,
OFFICE OF THE INSPECTOR GENERAL, DEPARTMENT OF DEFENSE,
400 Army Navy Drive, Arlington, Virginia 22202-2884

SUBJECT: Audit Report on the Cost-Effectiveness of the Air Force C-17 Aircraft Program
(Project No. 1AE-3020) (U)

1. This is in reply to your memorandum for the Assistant Secretary of the Air Force (Financial Management and Comptroller) requesting comments to the subject report.
2. The DoD IG objective for this draft report was clearly stated by the Senate Armed Services Committee on July 19, 1991 in the "National Defense Authorization Act for Fiscal Years 1992 and 1993 Report." After review of the draft report it appears that the only relevant portion to the stated objective is found at Appendix A - Results of the Senate Armed Services Committee Tasking. Appendix A fairly characterizes the life-cycle cost and performance analysis and model validity as stated. Initial tasking for a Cost and Operational Effectiveness Analysis (COEA) was made and is documented in the April 6, 1992 C-17 Program Management Directive. The C-17 program will comply with the DoD requirement to accomplish a COEA prior to the next milestone as directed by the Defense Acquisition Board (DAB) authority.
3. The C-17 has had numerous cost and performance analyses accomplished as a result of the continuing oversight provided to the C-17 program. The Assistant Secretary of Defense for Program Analysis and Evaluation completed and briefed the USD(A) on this specific topic March 5, 1991 as a part of the USD(A) directed review of the C-17. The conclusion stated that the C-17 continues to be the most cost effective airlift alternative. The Joint Chiefs of Staff are currently accomplishing a similar assessment based on the FY92 Defense Appropriations Bill's requirement for a Secretary of Defense report to Congress certifying the C-17.
4. The effective management of major acquisition programs cannot take place when the DoD leadership's every programmatic decision is continually called into question. Excessive oversight severely impacts a program from executing its approved acquisition strategy effectively. The management of DoD acquisition programs must remain in the hands of the Senior Acquisition Executive and the responsible services if we are to manage our programs effectively. I request your assistance to ensure that our established roles and responsibilities enhance rather than impede the process of acquiring the C-17 airlifter. My point of contact for the C-17 program in SAF/AQQU is Maj Maynard, 74138, if further information is required. Additional comments are attached.

Attachment


J. J. WELCH, JR.
Assistant Secretary of the Air Force
(Acquisition)

Assistant Secretary of the Air Force (Acquisition) Comments (Continued)

Final Report Reference

"COST EFFECTIVENESS OF THE AIR FORCE C-17 AIRCRAFT PROGRAM" DRAFT AUDIT REPORT (PROJECT NO. 1AE-5020) AIR FORCE COMMENTS ON RECOMMENDATIONS AND SPECIFIC ITEMS

20

1. Page 35, Recommendation 2 (U). Nonconcur. A C-141 service life extension program (SLEP) has been evaluated as an option on several occasions, most recently during the OSD Major Aircraft Review (Apr 90) and the OSD C-17 Program Review (Mar 91). A C-141 SLEP alternative is also included as an alternative in the C-17 cost effectiveness study currently underway as part of the five-part report to Congress on the C-17 program required by the FY92 Defense Appropriation Bill language. As a result of past and ongoing considerations of the C-141 SLEP option (addressing technical feasibility, operational capabilities, and cost considerations), the effort requested by this recommendation is a duplication of previous and ongoing assessments regarding the C-141. Also see comments in subparagraphs 3.j., 3.k., and 3.l. below.

20

2. Page 35, Recommendation 3 (U). Nonconcur. The recommendation to prepare documentation in support of a Defense Acquisition Board (DAB) review prior to the C-17 Lot V production contract award is unnecessary, primarily in light of the cost effectiveness study currently underway. On 21 February 1992, the USD(A), citing "extensive reviews of the C-17 program conducted over the last two years", cancelled the DAB review scheduled for May 1992 (Lot IV) and directed the next DAB to occur at Milestone IIIB after completion of the Operational Readiness Exercise prior to the award of Lot VII. This memo explicitly states the current DOD position referencing the next C-17 DAB review. In addition, the majority of the documentation stated in the recommendation is being accomplished as a result of other requirements, primarily in response to the congressional language contained in the FY92 Defense Appropriations Bill (the five-part SECDEF report to the Congress). In particular, the requirement for a cost and operational effectiveness analysis (COEA) is not required by regulation at this stage of the program (see paragraph 1. above) and would be a duplication of the effort underway to satisfy FY92 Congressional reporting requirements. COEAs were not required until the release of DODI 5000.2, dated 23 Feb 91. This instruction requires that a COEA be accomplished/updated at each program milestone. There is no direction to accomplish COEAs between milestones, even for special DAB reviews. DODI 5000.2, Part 4, Section E, subparagraph 3.e.(3) is explicit in this policy:

"At Milestone III, Production Approval, the analysis may be only an update of the Milestone II analysis. However, if there have been major performance or cost changes during phase II, Engineering and Manufacturing Development, a new analysis may be required. The elements of the analysis to be updated for a Milestone III review will be specified by the milestone decision authority as part of the pre-milestone planning process."

Assistant Secretary of the Air Force (Acquisition) Comments (Continued)

Final Report Reference

The next milestone decision (IIB, full rate production) for the C-17 program is currently scheduled for March 1995. Normally, a COEA is required early in a program before the Service even proceeds with FSED and, under the new DOD 5000 series, at Milestone I. The C-17 program (now 12 years old) is far past this requirement, completing full-up source selection in 1981, Milestone IIIA on 18 Jan 89, and all necessary program reviews. The effectiveness of a COEA diminishes as a program matures, enters into production, and alternative systems no longer exist (no other airlift aircraft in production). Major changes in performance and cost have been addressed at previous reviews and are again being assessed as part of the SECDEF certification to Congress, currently in progress. In addition, no direction has been received by the Air Force to accomplish a COEA from the milestone decision authority.

3. Specific Comments.

- 1, para. 2 a. Page 2, line 10 (U). For clarification, add the following to the end of the sentence ending on line 10: "...but because the funds appropriated were insufficient to procure a lot buy of two aircraft with supporting assets."
- 7, para. 2 b. Page 11, line 5 through page 12, ~~Exhibit~~ (U). This paragraph should be the first item in chronological order (beginning on page 10). It should begin with a discussion of the Chief of Staff of the Air Force (CSAF) directed requirements review in December 1989 and should end with the specification payload reductions in March 1991. As presently structured, this paragraph gives the false impression that the Air Force "backed in" requirements reductions, now in the current Systems Operational Requirements Document (SORD), after changes to the contract specification were completed.
- 8, para. 5 c. Page 12, line 23 (U). For accuracy, the last two lines of the last sentence should be changed as follows: "...1989 concluded that a range-payload point of 160,000 pounds at 2,400 nautical miles was more than adequate to support Army unit moves using the C-17 aircraft."
- 8, para. 6 d. Page 13, line 13 (U). The Air Force ~~has~~ reassessed the cost of buying a maximum of 18 aircraft per year with affordability as the main consideration.
- 9, para. 1 e. Pages 13 and 14 (U), Unit Cost. All costs should be identified as then-year (TYS) or base-year (BYS) dollars. Normally, costs are discussed in base-year dollars to make even comparisons.
- 9, para. 3 f. Page 15, line 20 (U). For clarification, add the following to the end of the last sentence of the second paragraph: "... (Appendix A) as recommended by the 1981 Congressionally Mandated Mobility Study (CMMS) conducted by the OSD, JCS, and the Services."
- 12, para. 6 g. Page 21, line 20 (U). For clarification, add "airfield" before "LCN." This will prevent confusion between airfield LCN and aircraft LCN.
- 13, para. 1 h. Page 22, line 3 (U). The sentence beginning on this line leads the reader to believe the C-5 is underutilized, and there is a possibility that the C-17 will not be used into shorter airfields. The reasons for limiting C-5 use in austere locations must be clarified. Although the C-5 is a very capable strategic airlift workhorse, the "Air Force imposed subsequent limitations"

Assistant Secretary of the Air Force (Acquisition) Comments (Continued)

Final Report Reference

16, para. 4

due to the C-5 having problems in constrained austere environments. Recommend this sentence be changed to explain that the limitations to C-5 operations in austere locations (inability to back; inability to turn in less than 150 feet; vectored thrust blowing sand, debris, tents, etc.; and a need for larger ramp areas) became primary design considerations for the C-17.

17, para. 1

i. Page 28, line 17 (U). Delete the word "only." Reference to "...the C-141 fleet has logged an average of only 33,600 hours..." insinuates the existing design life capability of the C-141 is 45,000 hours. In fact, the C-141 was originally designed for a service life of 30,000 hours without aerial refueling and high speed low-level flight ever envisioned. Both of these flight operations shorten an aircraft life by a factor greater than one. The fleet average is already 11 percent past its original design life even with the imposition of these unforeseen severe stress operations. The report should make these facts clear in addition to deleting the word "only."

j. Page 29, sentence beginning on line 3 (U). This sentence gives the impression the Air Force is doing all the modifications necessary to extend the C-141 service life, then turning around and retiring these aircraft before the end of the extended lifetime. This impression is false. In fact, the Air Force is being very careful to choose the aircraft which are in the worst condition to retire first before modifications are made (those that are the least safe to fly and need partial repairs the most), then extensively modifying the aircraft selected to be part of the fleet past the year 2000. Although modifications are ongoing to extend C-141 service life, not one aircraft has completed all the modifications necessary to lengthen service life from 30,000 to 45,000 hours. The aircraft selected to be part of the fleet past the year 2000 are programmed for complete modification. The Air Force has spent \$300M and programmed an additional \$800M for wing rework. Additionally, \$500M will be used to rehabilitate the main landing gear support structure, the pressure bulkhead, and the fuselage frame. These modifications are required to extend the C-141 service life. The Air Force is doing its utmost to preserve the C-141 fleet (including flight safety/structural integrity items). Limits have been in force in the areas of cargo loads, aerial refueling training procedures, and low-level operations (airspeeds and altitudes). There are currently 48 C-141s going through Periodic Depot Maintenance (PDM) and modifications. For essential clarification, these important points should be included in the report.

17, para. 2

k. Page 29, sentence beginning on line 15 (U). Although a few PDM tasks overlap the service life extension, most do not. Extending the PDM phase was selected after careful consideration of damage tolerance analysis, reliability centered maintenance, and cost savings (no significant gains were attributable to staying with a shorter cycle). Furthermore, the extended C-141 PDM cycle is now identical to that of the C-130 aircraft. Keeping a short PDM cycle for the C-141 would have done little additional over the present cycle to preserve the C-141 SLEP. This point needs to be clarified in the report.

18, para. 3

l. Page 31, line 23 through Page 32, line 8 (U). Delete this paragraph.

(1) The first sentence (citing a total cost of \$2.4B for 270 C-141s to extend service life to 60,000 hours) is unsubstantiated and an understatement that could lead to false program overruns if implemented. An estimate such as this should be further evaluated because it appears to omit service engineering and a structural teardown of a representative C-141 to baseline all modifications that would be required before any total SLEP cost could be aggregated. A

Assistant Secretary of the Air Force (Acquisition) Comments (Continued)

Final Report Reference

teardown is being accomplished on a BC-135H at Oklahoma City ALC to baseline modifications on that aircraft. Cost for the teardown will be \$4 to 7 million. Similarly, a C-141 aircraft would be required to have a teardown to get a highly accurate cost estimate. The DOD(IG) estimate for the C-141 is a minimum of one-half that necessary for just rewinging the aircraft. Teardown and fuselage work would add considerably more cost.

(2) Wing fatigue is not the only life restriction on an airframe. Fuselage corrosion, engine wear and efficiency, avionics maintainability, and other parts also wear out and must be factored into any SLEP decision. It should be noted that the Warner-Robins cost comparison does not include necessary improvements to the fuselage, landing gear support structure, the empennage, and other structures and systems that have deteriorated with age. Moreover, life extensions in these areas would be a continuation of 1950s technology that is inefficient and incompatible with today's operating environment.

(3) Because of the considerations/omissions cited in the two subparagraphs above, the estimate stated in this paragraph (\$2.4B) is considered to be at least one order of magnitude off the actual cost. An appropriate Air Force estimate for a complete SLEP, as discussed above (without new engines), is approximately \$7.5B. In view of this, recommend the paragraph be deleted or qualified by stating the above considerations/omissions.

28, para. 1

m. Page 40, Appendix A, line 25 (U). "...a series of in-house models developed and maintained by MAC." For clarification, these models were in fact extracted from AFR 173-13 and are Air Force approved.

35, Append. E

n. Page 43, Appendix C (U). The Airfield Analysis chart overstates the capability of the C-5 versus the C-17 by using a 90-foot wide runway. Request a note be added at the bottom of the page stating that the C-5, IAW MACR 55-2, requires a minimum of 150 feet to make a 180 degree turn (aircraft caster operative). Many of the airfields in this chart may not have adequate taxiways or turnaround areas.

AUDIT RESPONSE TO UNDER SECRETARY OF DEFENSE FOR ACQUISITION
COMMENTS

Our response to management comments by USD(A) on the factual content of the draft report follows and is numbered to correspond to the management comments.

1. We agree that the MRS did not identify mission needs that cannot be met by the 120-aircraft C-17 Program alone. For example, it did not address how 120 C-17's could fulfill all the missions now being met with 270 C-141's. For that matter, neither have any other analyses that we reviewed, which again underscores the need for a COEA. Further, the MRS projects a shortfall of 5-MTM/D based on moderate risk. The actual requirements shortfall, that is, from an unconstrained low-risk requirement, would be much greater, resulting in a need for more than an additional 34 C-17 PAA.

Regarding the time frame for a decision on capacity and composition of a future airlift fleet, a decision is required now. To delay a decision to 1996 would likely preclude the C-141 SLEP option and default to additional C-17's because 54 C-141's will be retired by the end of FY 1997, many other C-141's will likely be beyond economical repair, and a 2-year lag is expected from a decision date until the first refurbished C-141 would be ready. Such a scenario would preclude pursuing potentially cost-effective alternatives to a fleet comprised of no C-141 aircraft.

2. We have modified the referenced paragraph to include the need for less airlift because of the reduced threat of a multitheater global war. However, as the threat has further decreased since the MAR was conducted, this raises the question of whether as many as 120 C-17's are needed to meet airlift requirements and further supports the need for a COEA.

3. We have modified the referenced paragraph to change the date of Lot IV award from April 1992 to August 1992. We have also reflected this change in the "C-17 Buys through Lot VI" table in Part II.

4. Based on the "C-17 Selected Acquisition Report," December 31, 1991, we have modified the Lot V quantity/cost, Lot VI cost, and cumulative quantities and percents in the referenced paragraphs and table.

5. During our audit, we discussed the MAR calculation with the Office of the Director, Defense Research and Engineering. He stated that his office determined that 48-MTM/D was the 1990 estimate for the current airlift fleet, using factors from the "Airlift Master Plan," September 29, 1983. This plan used a

detailed analysis to determine airlift requirements, which were stated in terms of MTM/D. The goal was 66-MTM/D, but the 1989 baseline airlift capacity was 48.5-MTM/D.

The number of C-17's needed to replace the approximately 15-MTM/D lost by the planned retirement of 234 C-141 PAA was calculated by dividing 15-MTM/D by the .152-MTM/D per C-17 aircraft factor and arriving at roughly 100 C-17 PAA. Therefore, the MAR did not employ a detailed analysis, and MTM/D was the primary factor used to determine the size of the airlift fleet. Also, the MAR did not consider the total number of missions required, which would have affected the quantity of aircraft needed.

6. The MRS identified a 5-MTM/D airlift shortfall from the FY 1999 baseline airlift capacity of 57-MTM/D because of retirement of the remaining 152 C-141 PAA after FY 1999. In our opinion, the fact that a shortfall was identified implies that a requirement (i.e., 57-MTM/D) was established. The MRS outlines a number of airlift, not prepositioning, options for DoD consideration to maintain only a medium level of confidence (risk) for the baseline airlift capacity. Further, the MRS does not propose a C-141 SLEP as an option to satisfy future airlift requirements, and therefore does not address the consequences of waiting until 1996 to decide on requirements and options (see audit response 1).

Regarding the total airlift low-risk requirement, we are aware that the unconstrained low-risk requirement was noted, but believe that it, versus the moderate-risk requirement, should have been used as the mark from which to measure shortfall. We have modified footnote 1 to clarify this point.

7. During our audit, we discussed the conversion of PAA to total aircraft inventory with the Office of the Air Force Deputy Chief of Staff, Plans and Operations, who provided input to the MRS. He stated that the conversion factor for the total aircraft inventory was 117 percent of PAA, regardless of quantity. He also stated that the OSD Mobility Acquisition Manager's first position for the MRS was to use 40 C-17 total aircraft inventory to maintain the FY 1999 baseline airlift capacity, but the 40 total aircraft inventory was changed to 34 PAA in the published report. We have modified footnote 2 in our report to show the percentage break-out between training aircraft and backup aircraft inventory.

8. The "Defense Acquisition Executive Summary," January 25, 1992, estimated that Milestone IIIB and the Initial Operational Capability will occur in April 1994 and September 1994, respectively. We have changed the Milestone IIIB date in our report from May 1994 to March 1995, as stated in Air Force's comments to the draft report. However, this does not alter our conclusion that the Milestone IIIB date is too late to assess the most cost-effective combination of airlifters via a COEA.

9. We do not dispute the point that "After the MAR, the Deputy Secretary reviewed and approved the schedule for retirement of C-141s recommended by the Air Force."

10. During the MAR, two airlift fleet alternatives included 180 C-17 PAA buys (Appendix C). The one with the C-141 SLEP yielded 66-MTM/D (alternative 2d), but the one without the SLEP assumed all C-141's were retired and yielded only 60-MTM/D (alternative 2b). However, before the MAR, the future fleet assumed 180 non-SLEP C-141 PAA remained. We have reflected this fact in our discussion paragraph; however, this does not change our opinion that a C-141 SLEP should be included in the COEA.

AUDIT RESPONSE TO ASSISTANT SECRETARY OF THE AIR FORCE
(ACQUISITION) COMMENTS

In response to the Assistant Secretary of the Air Force (Acquisition) memorandum, we find it difficult to understand how he, as the Air Force Acquisition Executive, can conclude that oversight resulted in the cost, schedule, and performance problems associated with the C-17 Program. Instead, the oversight provided to the C-17 Program was based on, and provided necessary visibility into, these problems so that they could be properly addressed by management. Prudent program management can only occur when the decisionmakers are presented with accurate and complete information on which to base decisions. This is the essence of our recommendations to consider a potentially cost-effective means to meet future airlift requirements. To the extent program advocacy results in a failure to consider viable alternatives, DoD is not necessarily making the best use of its limited resources. Within an environment in which such advocacy exists, the argument that oversight hampers effective management has no validity. On the contrary, the logical conclusion is that objective oversight is essential.

Our response to management comments by the Assistant Secretary on the factual content of the draft report follows. Our numbered comments correspond to the letters (in parentheses) associated with the management comments.

1. We have added the suggested clause for clarification. (a)
2. It was not our intent to present a chronological sequence of events or to give the impression that the Air Force "backed-in" requirements reductions. (b)
3. Our intent was to state that the C-17 could meet the Army's maximum payload requirements. (c)
4. We have revised the statement addressing the affordability of buying 18 aircraft per year in full-rate production. (d)
5. The PAUC is stated in current (then-year) dollars. We have labeled this cost accordingly. (e)
6. We do not believe that this additional detail is necessary. (f)
7. We have added "airfield" before LCN for clarification. (g)
8. We disagree that our statements infer that the C-5 is underutilized or the C-17 would not be used on shorter airfields. (h)

9. We have deleted the word "only" from the statement. However, we have already stated that the original service life was 30,000 hours and provided an explanation about the severity of operations. (i)

10. Our support for this statement is the MAC document "Airlift and U.S. National Security: The Case for the C-17," 1991, page 11, which states that "The Air Force had initiated a relatively affordable repair and replace program to extend the service life to 45,000 hours. But even under this plan, the first C-141s would be forced to retire in the mid-1990s." (j)

11. We still believe that deferring PDM tasks (particularly, corrosion control tasks) and lengthening the PDM cycle will have an adverse affect on the service life of the C-141 fleet. (k)

12. Our \$2.4 billion (1990 dollars) estimate for 270 C-141's was derived in conjunction with Warner-Robins officials, and we used their documents as a basis for our calculation. In April 1992, Lockheed estimated that a SLEP for 150 C-141's would cost about \$3 billion (1991 dollars) or about \$20 million per aircraft. Even at a cost several times greater, we believe that a C-141 SLEP is a potentially cost-effective means of maintaining airlift capability in conjunction with the C-17. (l)

13. Clarification noted. (m)

14. We have already stated in our report that a C-5 takes about 150 feet to execute a 180-degree turn. Further, our analysis uses the same runway length and width criteria as does MAC in its document "The Case for the C-17, the Operator's View," January 1986, and in its contingency planning document for the C-5. Also, because we anticipated objection to such an analysis, we closely coordinated the runway criteria with MAC officials. Specifically, we discussed the use of a 90-foot versus a 150-foot wide runway. They concurred with the 90-foot width and said that it would conservatively represent the C-17's airfield advantage. (n)

AUDIT TEAM MEMBERS

Donald E. Reed, Director, Acquisition Management Directorate
Russell A. Rau, Program Director
Jack D. Snider, Project Manager
Dennis E. Coldren, Team Leader
Martin Gordon, Auditor
Eric Lewis, Auditor
Frank Ponti, Program Director, Audit Planning and Technical
Support Directorate, Quantitative Methods Division
Dharam Jain, Operations Research Analyst

INTERNET DOCUMENT INFORMATION FORM

A . Report Title: Cost-Effectiveness Analyses for the Air Force C-17 Program

B. DATE Report Downloaded From the Internet: 06/12/99

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): OAIG-AUD (ATTN: AFTS Audit Suggestions)
Inspector General, Department of Defense
400 Army Navy Drive (Room 801)
Arlington, VA 22202-2884

D. Currently Applicable Classification Level: Unclassified

E. Distribution Statement A: Approved for Public Release

F. The foregoing information was compiled and provided by:
DTIC-OCA, Initials: __VM__ Preparation Date 06/12/99

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